Microscopy Light Source

MC-LS

Remote Operations Guide

D20990.106 Rev A – DCN 13221

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Introduction

This Guide explains how to use the remote control interfaces of the SCHOTT Microscopy Light Source (MC-LS). Please refer to the MC-LS Quick Start User Guide for more information. All technical information can be downloaded by visiting **https://www.schott.com** and navigating to the MC-LS product page.

Remote Operation

Two connectors enable remote operation on the rear of the MC-LS, labeled USB and IN/OUT. The IN/OUT port is a standard 9-pin D subminiature receptacle that combines RS232 signal lines with additional digital and analog signals.

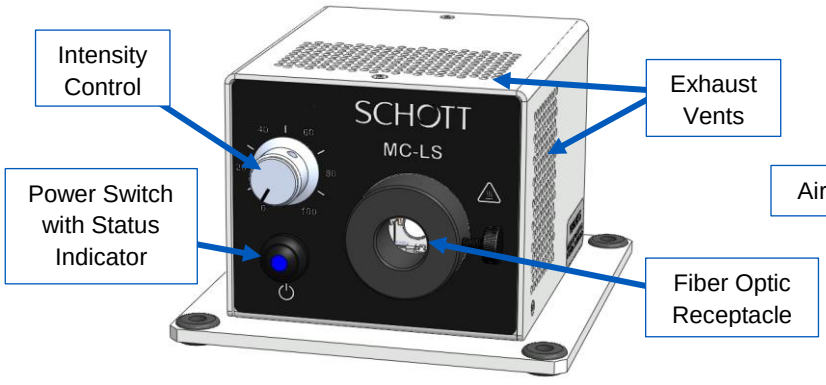


Figure 1 – Front Controls

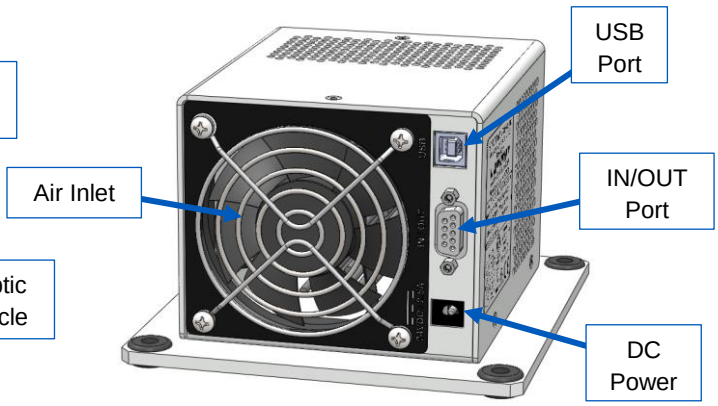


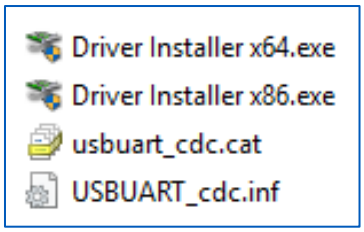
Figure 2 – Rear Controls

USB Port

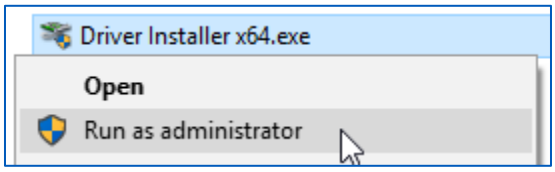
The USB port is a standard USB B receptacle that functions as a virtual COM port. In Windows, the port enumerates with the name "Cypress USB UART." The serial commands are described in the Serial Communication Protocol section.

USB Driver Installation

Windows drivers are available for download from the SCHOTT website. The driver package contains the following files:



Install the drivers by running Driver Installer x64.exe for 64-bit Windows systems and Driver Installer x86.exe for 32-bit Windows systems. The driver installation program may need to be run as an administrator, which is typically done by right-clicking the file name and selecting "Run as administrator" from the context menu.



IN/OUT Port

The IN/OUT port contains an RS232 port for serial communication and discrete digital and analog signals for basic remote control. The connector on the MC-LS is a standard female 9-pin D-Sub receptacle. The pinout is described in Figure 3 and Table 1.

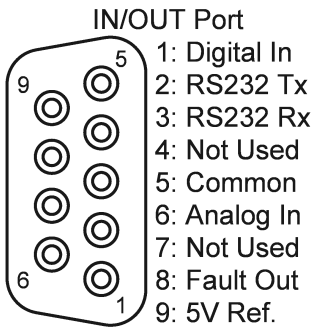


Figure 3 – IN/OUT Port Pinout

Pin	Name	Specification
1	Digital In	Digital input, 10kΩ input impedance. Low < 0.7V, High > 3.7V Internal pull-up causes input to be high when disconnected.
2	RS232 Tx	RS232 transmit
3	RS232 Rx	RS232 receive
4	Reserved	Do not connect
5	Common	Common pin for all signals
6	Analog In	Analog input for LED intensity adjustment. Range: 0-5V, 16kΩ input impedance
7	Reserved	Do not connect
8	Fault Out	Digital output, open collector Rated for 30V/10mA
9	5V Ref.	5V/10mA output

Table 1 – IN/OUT Port Pin Specification

RS232 Signals

The RS232 interface uses three pins: 2 (Tx), 3 (Rx), and 5 (Common). The port is configured to operate at 9600 baud, 8 data bits, 1 stop bit, and no parity. The serial commands are described in the section Serial Communication Protocol.

NOTE: Some PC serial ports and USB-Serial converter cables have a low impedance connection between Pins 1 and 5, which drives the digital input pin low, disabling the LED output when the serial cable is plugged in. In this case, change the polarity of the digital input pin to "Low = LED on" using the serial command "&J1". See section J – Digital Input Polarity. The setting change reverts to the previous value when power is cycled. To save the setting, see section S – Save Settings.

Analog/Digital Control

Four pins are provided on the IN/OUT port for simple on/off control, intensity adjustment, and fault monitoring using just a few external components. Refer to Figure 4 for an example circuit for a remote control application.

The digital input pin has an internal pull-up that causes the input to be "high" when disconnected. Connecting the pin to Common (pin 5) drives the input low ("active low").

When the pin is not active, the LED output turns on and off as expected (e.g., when the front button is pressed or the appropriate serial command is received). When the pin is active (low by default), the LED output turns off regardless of any other input.

The active state of the digital input can be reversed with the J – Digital Input Polarity command. For example, if the "&J1" command is sent, the LED turns off when the input pin is high and operates normally when the pin is low.

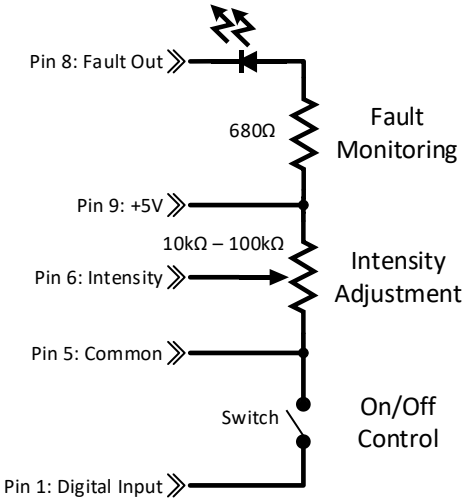


Figure 4: Example Remote Control Circuit

Additionally, the functional behavior of the digital input can be changed to accommodate different types of switches with the JM – Digital Input Mode. For example, the digital input can be configured to turn on/off the LED with a toggle or rocker switch, where the state of the output is dependent on whether the switch is opened or closed. The digital input can also switch the LED on/off with a momentary pushbutton or footswitch where the LED output toggles on or off with each switch press.

The J and JM commands allow for any type of switch to be used to enable or disable the light source, such as a rocker switch or a pushbutton switch. Refer to the individual command descriptions for details.

Serial Communication Protocol

Remote communication with the MC-LS follows a command-response pattern. A command must be sent to control the unit or query an operating parameter. Once received, the unit performs the requested action and sends a response.

The unit accepts commands through the serial interfaces in the form of ASCII strings. Commands are used to control (e.g., disable/enable the LED output, adjust intensity, change settings, etc.) or query the unit's operational status (e.g., LED enabled/disabled, intensity, temperature, voltage, etc.).

Unless otherwise noted in the command descriptions below, configuration changes are not saved until the **S – Save Settings** command is sent. On power-up, the MC-LS reverts to the last saved settings or the factory default if no saved settings exist.

Command Structure

The structure of the string for a MC-LS serial command is organized as follows:

<Start><Command><Parameter><Terminator>

Position	Format	Description
<Start>	&	A command string always starts with the ampersand (&) character. The parser ignores all characters until this character is received, indicating the start of a command.
<Command>	1-3 letters	Consists of one, two, or three letters indicating the desired command. The unit does not distinguish between upper and lowercase characters; however, responses are always lowercase.
<Parameter>	? or 1-5 alphanumeric digits	If '?' follows the Command Mnemonic, the command is a query. No other characters may follow the '?' except for the termination character. If a question mark does not immediately follow the command mnemonic, the command is a parameter. Parameters are used to change a setting or control the operation of the unit.
<Terminator>	Carriage Return	The termination character ends the command or response. The command string is processed once the termination character is received. The carriage return is ASCII code 13 (0x0D) and is denoted as '\r' in many programming languages.

Responses

The MC-LS responds to input commands with a string of characters as described in the following sections. The maximum length of the response is 64 characters (63 characters + terminator character), though most responses are fewer than 10 characters. All responses end with the Terminator character as described in the table above.

Acknowledgment (No Error)

If the command was received and processed without error, the response is as described in the command's description below. Generally, the response to a control command is identical to the string that was initially sent. The response to a query command starts with the command string, followed by the requested parameter.

Negative Acknowledgement (Error)

The following table describes the types of negative acknowledgments:

Type	Response
Invalid character received	Response: &nX^Y &n = Negative acknowledgment X = Characters in the command string that were parsed correctly ^ = Invalid character location start Y = Invalid character received Examples: Command: &L5 Response: &nl^5 (5 is not a valid parameter for this command) Command: &HLZ Response: &nhl^z Explanation: The characters "HL" are the first letters of a valid command, but the "Z" is not.
Buffer Overflow	Response: "USB receive buffer error" or "Uart receive buffer error," depending on which port experienced the overflow. The error message is transmitted after a Start Character (&) is received, followed by 63 non-Termination Characters.
Termination Character received before Start Character	Response: "Invalid command"
Timeout	Response: &n Once the Start character is received, a timer is started. Whenever another character is received, the timer is reset. If 10 seconds elapses since the last character was received and that character wasn't the Terminator, the MC-LS responds as described. The timeout timer stops when a timeout occurs or if the Terminator is received.

Command Details

A0 – Knob Input Value

&A0?	Get the front knob position as a percentage of full scale. Response: **&a0$** Value ($): **0000** to **1000** as a percentage of full-range Example response: **&A00514** (the front knob is at the 51.4% position)

A1 – Rear Analog Input Value

&A1?	Get the rear analog input as a percentage of full scale (0 – 5V). Response: **&a1$** Value ($): **0000** to **1000** as a percentage of full scale Example response: **&A10230** (the analog input is 23.0% of full scale, or 5V * 0.23 = 1.15V)

BT – Board Temperature

&BT?	Get the current temperature of the internal PCB in Celsius. Response: **&bt$** Value ($): **00.0** – **99.9**

C – System Faults

&C?

Get the system faults as a bit field.

Response: **&c$**

Value (**$**): A hexadecimal value that represents the errors present. Errors are determined by converting the decimal value to an 8-bit binary value. A "1" at a particular bit position indicates an error. Refer to the table below.

Bit	Fault	Description
0	LED	LED disconnected or open-circuit
1	Fan	Fan not turning
2	Input voltage	Input voltage < 20V or > 30V
3	LED heatsink temperature	Heatsink temperature > 70°C
4	Board temperature	Internal PCB temperature > 60°C
5	*Reserved*	
6	*Reserved*	
7	*Reserved*	

Example #1: response **&c02** → 2 hex = 00000010 binary

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	1	0

Bit 1 (fan) is the source of the error.

Example #2: response **&c15** → 15 hex = 00010101 binary

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	1	0	1	0	1

In this case, there are three faults: bit 0 (LED), bit 2 (input voltage), and bit 4 (internal PCB temperature).

D0 – Front Switch State

&D0?	Get the state of the front switch. Response: **&d00** = switch not pressed **&d01** = switch pressed

D1 – Remote Digital Input State

&D1?	Get the state of the digital input of the IN/OUT port (pin 1). Response: **&d10** = low **&d11** = high **NOTE:** This input will read "high" when the pin is disconnected.

F – Firmware Version

&F?	Get the firmware version of the unit Response: **&f$** Value (**$**): A string containing the version number. Example response: **&f1.0** = Firmware version "1.0"

G – Fan Speed

&G?	Get the fan speed in RPM. Response: **&g$** Value (**$**): Fan speed in RPM.

HLF – Front Control Lockout

&HLF#	Enable or disable the front panel knob and button controls. Parameter (#): **0** = disable the controls **1** = enable the controls (default) **?** = query the current state. Response: **&hlf0** = the control is disabled **&hlf1** = the control is enabled See also **K – Control** Lockout

HLM – Remote Analog Control Lockout

&HLM#	Enable or disable the remote analog input. Parameter (#): **0** = disable the analog input **1** = enable the analog input (default) **?** = query the current state. Response: **&hlf0** = the control is disabled **&hlf1** = the control is enabled NOTE: The digital input is not disabled by this command. See also **K – Control** Lockout

I – LED Intensity

&I#	Set or get the LED intensity with 8-bit precision. Parameter (#): A 2-digit hexadecimal value between 0 and FF (decimal 255) where 0 is minimum intensity (i.e., off) and FF is maximum intensity. The current light intensity can be queried by sending '?' as the parameter. Response: **&i$** Value ($): The intensity value as a 2-digit hexadecimal value (see parameter explanation).

IP – LED Intensity (Precision)

&IP#	Set or get the LED intensity with 11-bit precision. Parameter (#): A 3-digit hexadecimal value between 0 and 7FF (decimal 2047) where 0 is minimum intensity (i.e., off) and 7FF is maximum intensity. Any value higher than 7FF is interpreted as 7FF. The current light intensity can be queried by sending '?' as the parameter. Response: **&ip$** Value (**$**): The intensity value as a 3-digit hexadecimal value (see parameter explanation)

J – Digital Input Polarity

&J#	Get or set the active polarity of the digital input pin of the IN/OUT port (pin 1). Used in conjunction with the **&JM#** command, the pin can be configured to enable/disabled the LED output using either a toggle switch or momentary pushbutton switch. Parameter (#): **0** = LED off when low or toggle on falling edge (default) **1** = LED off when high or toggle on rising edge **?** = query current setting Response: **&j0** = LED off when low **&j1** = LED off when high

JM – Digital Input Mode

&JM#	Get or set the switching mode of the digital input pin of the IN/OUT port (pin 1). When used in conjunction with the "J" command, the pin can be configured to enable/disabled the LED output using either a toggle switch or momentary pushbutton switch. Parameter (#): **0** = level triggered (default) **1** = edge triggered **?** = query current setting Response: **&jm0** = level-triggered (toggle switch) **&jm1** = edge triggered (momentary switch)

K – Control Lockout

&K#	Get or set the control lockout setting. Parameter (#): **0** = all controls enabled (default) **1** = front knob and switch disabled **2** = analog input disabled **3** = front knob, switch, and analog inputs disabled **?** = query current setting Response: **&k0** = all controls enabled **&k1** = front knob and switch disabled **&k2** = analog input disabled **&k3** = front knob, switch, and analog inputs disabled See also **HLF – Front Control** Lockout and **HLM – Remote Analog Control** Lockout.

L – LED Output Enable

&L#	Enable or disable the LED output. This command enables the LED driver and fan, even if the intensity is set to the minimum value. Parameter (#): **0** = LED disabled (default) **1** = LED enabled **?** = query current setting Response: **&l0** = LED disabled **&l1** = LED enabled

LT – LED Heatsink Temperature

&LT?	Get the heatsink temperature in degrees Celsius. Response: **&lt$** Value (**$**): **-5.0** to **99.9**

M – Control Source

&M?	Get the interface that is controlling the unit. An interface gains control of the unit if it adjusts the intensity or enables/disables the LED. The RS232 and USB ports claim control whenever the "L", "I", or "IP" commands are sent. The front panel or rear analog input claim control when the power button is pressed, the digital input is toggled, or the light intensity is adjusted. Response: **&m$** Value (**$**): **Value** / **Meaning** 0 – Front Panel Control 1 – Rear Analog Control 2 – RS232 Port 3 – *Reserved* 4 – USB Port 5 – *Reserved* 6 – *Reserved* 7 – None

O – Restore Factory Defaults

&O	Restore the unit to the factory default settings. This command resets the unit to the factory default settings. Response: **&o$** Value (**$**): **0** = success **1** = reset failure

O4 – Reboot System

&O4	Reboot the firmware. This command has the same behavior as power cycling the unit. Response: **none**

Q – Product Name

&Q	Get the product name. Response: **&qSCHOTT Microscopy Light Source (MC-LS)**

S – Save Settings

&S	Saves the unit's current operating state to internal memory, overwriting any previous settings that may have been stored. The unit immediately begins operating using these saved settings the next time power is cycled or when the **T – Restore Settings** command is used. The current operating state includes the following settings: • LED output status (see L – LED Output Enable) • Intensity (see IP – LED Intensity (Precision) • Control source (see M – Control Source) • Control lockout status (see K – Control Lockout) • Switch polarity (see J – Digital Input Polarity) • Switch mode (see JM – Digital Input Mode) Response: **&s$** Value (**$**): **0** = success **1** = failure

T – Restore Settings

&T	Restores the unit to the currently saved settings. See **S – Save Settings** for details on which settings are restored. Response: **&t$** Value (**$**): **0** = success **1** = failure

VI – Input Voltage

&VI?	Gets the input voltage. Response: **&vi$** Value (**$**): The input voltage as a decimal number in the format ##.##

W – System Warnings

&W?	Get the system warnings as a bit field. Response: **&w$** Value (**$**): A hexadecimal value indicating the warnings that are present. The response is formatted identically to **C – System Faults**.

Bit	Warning	Description
0	*Reserved*	
1	*Reserved*	
2	Input voltage	Input voltage < 22V or > 26V
3	LED heatsink temperature	Heatsink temperature > 65°C
4	Board temperature	Board temperature > 55°C
5	*Reserved*	
6	*Reserved*	
7	*Reserved*	

XS – Status Summary

&XS$

Gets a comma-delimited listing of various status values by combining the output of several commands into a single response.

Response: **&xs$**

Value (**$**): A comma-delimited list of various status and control values in the following format:

&xs,A,B,C,D,E,F,G,H,I,J,K,L,M

ID	Response from Command	Description
A	&C?	System faults
B	&W?	System warnings
C	&IP?	Intensity (Precision)
D	&L?	Light output enable status
E	&BT?	Board temperature
F	&LT?	LED heatsink temperature
G	&G?	Fan speed
H	&VI?	Input voltage
I	&A0?	Front knob position
J	&A1?	Analog input value
K	&D0?	Front button state
L	&D1?	Digital input state
M	&M?	Control source

Example response:

&xs00,00,222,1,+26.5,+24.2,2518,23.45,0503,0200,0,1,4

00 no errors
00 no warnings
222 LED intensity is 0x222 → 546 decimal → 546/2047 = 26.7%
1 LED enabled
26.5 Temperature of control board is 26.5°C
24.2 Temperature of heatsink is 24.2°C
2518 Fan speed 2518 RPM
23.45 Input voltage is 23.45V
0503 Front knob is set to 50.3%
0200 Analog input is 21.1% of full scale (5V * 20.0% → 1.0V)
0 Front button is not pressed
1 Digital input is high
4 Control source is the USB port

Z – Serial Number

&Z$	Get the unit's serial number. Response: **&z$** Value (**$**): A string containing the unit's serial number. Example response: **&z000001** (serial number 1)

ZM – Model Number

&ZM$	Gets the unit's model number. Response: **&zm$** Value ($): A string containing the unit's model number. Example response: **&zmA20990** (model number A20990)

KL 2500 LED Protocol Compatibility

The MC-LS serial interface is compatible with KL protocol version 2.0 as used on KL 2500 LED.

Command Structure

The command structure is identical to the MC-LS commands.

<Start><KL_Command><Parameter><Terminator>

Position	Format	Description
<Start>	Zero "0"	Address byte to select a channel of the light source(s). The current protocol only allows for a single address, so the only recognized character is "0".
<KL_Command>	2 characters	A two-character mnemonic of the command. The commands are described in detail below.
<Parameter>	'?' or 4 characters	If '?' follows the Command Mnemonic, the command is a query. The termination character must always follow the '?'. If a question mark does not immediately follow the command, the command is a parameter. Parameters are used to change a setting or control the operation of the unit. Parameter details are given for each command.
<Terminator>	Semicolon ";"	The termination character ends the command. The command string is processed once the termination character is received. The carriage return is ASCII code 13 (0x0D) and is denoted as '\r' in many programming languages.

Responses

Acknowledgment (No Error)

If the command was received and processed without error, the response is as described in the command's description below. Generally, the response to a control command is identical to the string that was initially sent. The response to a query command starts with the command string, followed by the requested parameter.

Negative Acknowledgment (Error)

If the command was not parsed correctly, the unit sends a response from the following table:

Code	Description
0!003;	Unknown command
0<Command>!006;	Value is out of range
0<Command>!009	Value is not a number

Command Details

BR – Brightness

0BR#;	Set or get the brightness setting of the light source. See also the **I – LED** Intensity and **IP – LED Intensity (Precision)** commands. Parameter (#): A 4-digit hexadecimal value between 0 and 3E8 (decimal 1000) where 0 is minimum intensity (i.e., off) and 3E8 is maximum intensity. Values higher than 3E8 are interpreted as 3E8. ? → the current value Response: **0BR$;** Value ($): The intensity value as a 4-digit hexadecimal value (see parameter explanation). Examples: • **0BR01F4;** 01F4 hex→500 dec (50%) • **0BR03E8;** 03E8 hex→1000 dec (100%) • **0BRFFFF;** FFFF hex > 3E8 hex so intensity will be set to 100%.

ID – Identification

0ID?;	Identifies the light source. Response: **0IDKL 2500 LED V2.0 (MC-LS Vxxx);** (xxx is the firmware version)

LK – Front Panel Control Lock

0LK#;	Lock the front panel controls at the light source. See also the **HLF – Front Control** Lockout and **K – Control** Lockout commands. Parameter (#): 0 → unlock 1 → lock ? → query Response: **0LK$;** Value ($): The current state.

PR – Recall Preset

0PR#;	Recalls the user preset values. The index value used in the KL protocol is ignored by the MC-LS. Only a single preset slot is used. See also the **T – Restore** Settings command. Parameter (#): The index value used in the KL protocol is ignored by the MC-LS. Only a single preset slot is used. Response: 0PR0001;

PS – Store Preset

0PS#;	Store the current settings as a preset in the light source. The next time power is applied, it will start-up in the preset state. See also the **S – Save** Settings command. Parameter (#): The index value is ignored by the MC-LS. Only the first preset slot is used regardless of the index value received. Response: **0PS0001;**

PV – Protocol Version

0PV?;	Get the protocol version. The first byte represents the version, the second byte the revision. Response: **0PV0200;** (KL protocol version 2.0)

SF – Switch Mode

0SF#;	Determines the behavior of the digital input so that either a momentary or a toggle switch can be connected. **This setting is saved in the internal memory of the light source after it is changed.** Parameter (#): 0000 → momentary switch (push button, footswitch) 0001 → toggle switch (ON/OFF, rocker) (default mode) ? → query the current state Response: 0SF$; Response value ($): The current state of the setting See also the **J – Digital Input** Polarity and **JM – Digital Input** Mode commands. Note that the "J" and "JM" commands do not automatically save the setting after it is changed.

SH – Shutter Enable

0SH#;	This command emulates a shutter as used with halogen light sources. See also the **L – LED Output** Enable command. Commands: **0SH0001;** → shutter activated (light off) **0SH0000;** → shutter deactivated (light on) **0SH?;** → query the current state

TX – Temperature of LED Heatsink

`0TX?;`	Gets the temperature of the internal LED heatsink as an integer in steps of 0.0625 Kelvin. Example response: `0TX129c;` → 129c hex → 4764 dec → 4764 * 0.0625K + 275.15K = 22.6°C

Warranty and Liability

SCHOTT warrants our light sources to be free from defective workmanship and materials. If within two (2) years from shipment date, any product and/or part thereof are determined by SCHOTT to be defective, SCHOTT will repair or replace it with a new or reconditioned product and/or part.

Warranty is void if:

- We determine the product has been subjected to neglect or misuse or has been installed following procedures not in accordance with our instruction manual.
- Unauthorized repairs or modifications have occurred.
- The warranty seal has been broken, or the serial number label has been altered.

Our obligation is limited to repair or replacement. SCHOTT will not be held responsible for consequential damages, transportation, installation, adjustment, or other expenses arising in connection with our products or parts. This warranty is in lieu of all other statements or guarantees, written or implied, by SCHOTT or SCHOTT authorized representatives.

Servicing

There are no user-serviceable components inside the MC-LS. All repairs must be made by an authorized repair facility. Opening the housing of the unit voids the warranty. Please contact your distributor or SCHOTT sales representative for technical support.

Contact Information

Customer Support

Lighting and imaging
SCHOTT North America, Inc.
122 Charlton Street
Southbridge, MA 01550
Phone: (508) 765-9744
Fax: (508) 765-1299
Email: **lightingimaging@us.schott.com**
Website: **https://www.schott.com**

Technical Support

For technical support, please contact your distributor, SCHOTT sales representative, or email **lightingimaging@us.schott.com**.

The latest product information can be found on the SCHOTT website at **https://www.schott.com/**

Manufacturing Location

SCHOTT de México, S.A. de C.V. (Plant #3540)
Carretera México-Veracruz Km.349 Venta Parada,
Amatlán de los Reyes, Veracruz México 94946
Phone: +52 (271) 7166-316

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